REMARKS

Claims 1-40 remain in the application. New Claims 21-40 are added, which are directed to a method of electrically switching between two different states in an electric field activated molecular switch, wherein the switch comprises a crossed-wire device comprising at least one pair of crossed wires that form a junction where one wire crosses another at an angle other than zero degrees and at least one connector species connecting the pair of crossed wires in the junction. The junction has a functional dimension in nanometers and the connector species comprises a molecular system that has an electric field induced band gap change that occurs via one of the following mechanisms:

(1) molecular conformation change or an isomerization;

(2) change of extended conjugation via chemical bonding change to change the band gap; or

(3) molecular folding or stretching.

The method comprises applying a voltage to a pair of wires to cause a change in the state of the molecular system at the junction thereof. The claims are analogous to Claims 1-20, respectively, and are amply supported by the specification.

Claims 1-3, 6-9, 11-12, 15-16, and 18-20 are rejected under 35 USC 102(e) as being anticipated by Heath et al (U.S. Patent 6,198,655).

Heath et al disclose electrically addressable volatile and non-volatile molecular-based switching devices. The molecular devices include certain [2] catenanes as bist-able molecules which are sandwiched between two switch terminals. The switches are said to be extremely small and have dimensions which range from several microns down to a few nanometers. This reference is quite similar to U.S. Patent 6,459,095, cited in paragraph 0002 as amended in its disclosure of catenanes.

Applicants' Claim 1 recites:

> 1. An electric field activated molecular switch comprising a molecular system that has an electric field induced band gap change that occurs via one of the following mechanisms:
>
> (1) molecular conformation change or an isomerization;
>
> (2) change of extended conjugation via chemical bonding change to change the band gap; or
>
> (3) molecular folding or stretching.

The Examiner argues that Heath et al disclose a molecular switch. Applicants agree.

The Examiner argues that the operation of the switch is by the change in energy level, citing Figures 5A and 5B, which the Examiner states are energy diagrams.

While Figures 5A-5B are, indeed, energy barriers, the energy diagrams have nothing to do with valence band, conduction band, or band gap. Rather, these energy diagrams show that the switching mechanism is based upon oxidation of the molecule (see Col. 6, line 59 to Col. 7, line 7 and Col. 7, lines 20-31).

The Examiner argues that there is a change in the configuration of the molecules, citing Col. 3, lines 37-41, which, the Examiner contends, is the same as a change in the conformation.

The Examiner has apparently confused the term "change of **configuration**" of the molecules of Heath et al with Applicants' "change in **molecular conformation**". The term "change of **configuration**" used by Heath et al refers a change in its "potential" state of the molecule via an oxidation or reduction (redox) process (col. 3, lines 42-56). Applicants' "**molecular conformation** change" refers an E-field induced molecular conformation change via a ***non***-redox process. A "change in energy level" through a **redox** process is an ***electrochemical*** reaction, even though there might be a ring rotation among the interlocked rings of the catenanes. The ring rotation among the interlocked rings of the catenanes is a side effect of the ***electrochemical*** reaction. Applicants' "electric field induced band gap change" is achieved directly via a ***non***-redox process and is a purely ***physical*** process. There is a distinct difference between them. This distinction is made throughout the specification; see, e.g., paragraphs 0005 and 0006, which discuss rotaxanes and catenanes, together with paragraphs 0016, 0017, and 0071, which point out the advantages of Applicants' E-field devices over electrochemical devices, such as disclosed by Heath et al.

The Examiner argues that the molecular material is between electrodes. Applicants agree.

The Examiner argues that the molecular shape change causes an energy barrier, citing Col. 5, lines 55-67, which, the Examiner contends, satisfies the limitation that the band gap change occurs via molecular conformation change.

A change in the energy barrier (total system potential energy) **for electron tunneling**, as done by Heath et al, is completely unrelated to the **HOMO-LUMO band gap changes** claimed by Applicants. The former deals with potential energy of all sigma-, pi- and non-bonding orbitals in the total molecular system. The latter only deals with the two orbitals of HOMO and LUMO; these are closely associated with the p- and pi-electrons of the molecule. Change in the energy barrier (or total system potential energy) does not necessarily change the molecular HOMO-LUMO band gap, whether it has any conformation or configuration change or not if there is no change in the extended pi-bonding in the molecular system. The HOMO-LUMO band gap change is due to the change of extended pi-bonding in the system, which does not necessarily affect the total system potential energy either.

The Examiner argues that the configuration change includes rotation under an applied voltage or electric field, and, pointing to Figure 4B, contends that there is extended pi bonding in the molecule, which would change in energy level as indicated by the energy diagrams of Figures 5A and 5B, citing Col. 6, lines 15-25 and 40-52. The Examiner further argues that Figure 4B also shows the folding.

The Examiner appears to confuse the molecule of Heath et al molecule (in Fig. 4B) with Applicants' "molecular band gap change via electric field induced change of molecular folding or stretching".

First, the catenanes used by Heath et al are molecules consisting of two or more pre-made interlocked rings. Each of the interlocked rings is fixed in shape and cannot be "folded".

Second, there is no extended pi-bonding in the molecule shown in Fig. 4. Each ring of the interlocked rings of the catenanes of Heath et al is constructed by connecting each fragment of some conjugated aromatics or heterocycles with insulating fragments via sigma-bonding. The catenanes are molecular structures with many localized pi-bonding sites instead of an extended pi-bonding system. Each localized pi-bonding site within the catenanes does not change during the switching via a redox reaction. Thus, there is no extended pi-bonding change during the process.

Third, the "catenanes" used by Heath et al are molecules that can change energy configuration via an electrochemical reaction with voltage (or potential) with

no change of extended pi-bonding, even though there might be a ring flip after electrochemical reaction. In the instant application, Applicants change the molecular band gap due to the change of extended pi-bonding system via a molecular conformation change induced by an external E-field. It is purely a field effect, and not an electrochemical effect.

The Examiner argues that the electrode wires are at an angle and that they are crossing. Applicants agree.

The Examiner also argues that the devices which can be formed may be a memory cell and that the dimensions of the devices are nanometers. Applicants agree.

The Examiner should understand that Heath et al. use catenanes (a type of redox-based molecule) for molecular switches. Catenanes consist of two or more interlocking rings, each of which may be prepared as a separate and distinct molecule (Col. 4, lines 5-10). In Applicants' application, several classes of molecules are disclosed that can undergo electric field induced band gap change via one of the following mechanisms: (1) molecular conformation change or an isomerization; (2) change of extended conjugation via chemical bonding change to change the band gap; or (3) molecular folding or stretching. As mentioned above, the two mechanisms of switching are distinctly different, and the existence of one switching mechanism cannot prevent the patentability of molecular species exhibiting a distinctly different mechanism of switching. The former is electrochemical and the latter (Applicants') is physical.

Using the Examiner's logic would suggest that a field effect transistor could not be patentable over a bipolar transistor. Both are three terminal devices and both employ silicon. However, Applicants submit that patentability of the FETs is based, at least in part, on the different mechanisms of electron transfer, and those are both physical processes, whereas the Examiner here is contending that a physical process is unpatentable over a chemical process.

Moreover, the Examiner is respectfully requested to point out where in Heath et al any of the specific embodiments of Applicants' invention, as recited in Claims 3-57-14, and 16-17 are disclosed. Applicants urge that, contrary to the Examiner's blanket rejection, these claims are not remotely disclosed or suggested by [2] catenanes.

The same arguments made above obtain for new Claims 21-40 as well.

Reconsideration of the rejection of Claims 1-3, 6-9, 11-12, 15-16, and 18-20, together with new Claims 21-40, under 35 USC 102(e) as being anticipated by Heath et al is respectfully requested.

Claims 1-20 are rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over Claims 1-7 of U.S. Patent 6,763,158.

The Examiner argues that the claims are not patentably distinct from each other because the claims differ in the recitation of a molecular switch and of an optical switch. The Examiner further argues that it would have been obvious to one of ordinary skill in the art that a molecular switch can be used as an optical switch.

Applicants vigorously disagree with the Examiner. First, the cited patent is a continuation-in-part of the present application, and thus is later in time in the invention of the instant application. Second, molecules that are suitable for electronic switching are not necessarily suitable for optical switching. The Examiner is respectfully requested to either cite a reference (pre-dating the filing date of the present application) supporting the Examiner's position or provide an affidavit in accordance with 37 CFR 1.104(d)(2).

The Examiner finally states that the recitation of an optical switch in the preamble is simply a statement of use, and the molecule is not patentably different.

While it is true that the generic molecule claimed is the same in both instances, the fact that a molecule that is suitable in electronic switching is not necessarily suitable in optical switching renders the two claims patentable. Specifically, Claim 1 of the instant application recites "An electric field activated molecular switch comprising a molecular system ...", while Claim 1 of the cited patent recites "An electric field activated optical switch comprising a molecular system ...".

Finally, it is noted that the specific molecular systems claimed herein are completely different than the specific molecular systems claimed in the cited patent. This adds further support to Applicants' contention that there is not necessarily equivalence between electronic switching molecules and optical switching molecules.

Nevertheless, in an attempt to advance the prosecution, a Terminal Disclaimer, signed by Susan E. Heminger, agent of record, is enclosed herewith.

Reconsideration of the rejection of Claims 1-20 under the judicially created doctrine of obviousness-type double patenting as being unpatentable over Claims 1-7 of U.S. Patent 6,763,158 is respectfully requested.

The Examiner cites Schlag (US-2002/0158244) as being relevant to Applicants' disclosure. Applicants have reviewed this reference and consider that it neither discloses nor suggests Applicants' invention, whether taken alone or in combination with the previously cited references.

The foregoing amendments and arguments are submitted to place the application in condition for allowance. The Examiner is respectfully requested to take such action. If the Examiner has any questions, the Examiner is invited to contact the undersigned at the below-listed telephone number. HOWEVER, ALL WRITTEN COMMUNICATIONS SHOULD CONTINUE TO BE DIRECTED TO: IP ADMINISTRATION, LEGAL DEPARTMENT, M/S 35, HEWLETT-PACKARD COMPANY, P.O. BOX 272400, FORT COLLINS, CO 80527-2400.

Respectfully submitted,

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David W. Collins
Reg. No. 26,857
Attorney for Applicants

75 West Calle de las Tiendas
Suite 125B
Green Valley, AZ 85614

Telephone calls may be made to:
(520) 399-3203